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# AN EVALUATION OF GALL RUST-ASSOCIATED MORTALITY IN MATURE JACK PINE STANDS ON THE CHEQUAMEGON NATIONAL FOREST, 1978

by

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## INTRODUCTION

The Northeast Corner Planning Area is a 20,000-acre tract of land, located on the Washburn Ranger District, Chequamegon National Forest. In the 1930's, approximately 8,900 acres of this tract was planted primarily to jack pine. Most of these stands are approaching rotation age and will be cut within the next 10 to 15 years.

Within the last 5 years, significant mortality has been noted in a number of these stands. Some of the mortality was associated with an outbreak of the jack pine budworm, Choristoneura pinus Freeman and subsequent root rot by Armillaria mellea Vahl. ex Fr. (Anderson 1975). However, recent observations by the author and personnel on the National Forest suggested that much of the mortality might be related to the incidence of Eastern gall rust, Cronartium quercuum (Berk.) Miyabi ex Shirai f. sp. banksianae. This evaluation was conducted in response to a request for such by the Forest Supervisor, Chequamegon National Forest. This information will be used to set priorities for stands to be harvested over the next three years.

## OBJECTIVE

To determine present volume losses and predict imminent losses in merchantable timber due to diseases in 21 selected jack pine stands on the Washburn Ranger District, Chequamegon National Forest.

# MATERIALS AND METHODS

## FIELD

A list of the stands to be evaluated along with compartment maps for these stands were provided by the district timber management section. Using this information, 15 sample points were systematically selected in each stand.

At each sample point the following information was noted using a variable prism plot (10 BAF): Number of trees which died during the past year; number of trees which were expected to die during the next two years; number of healthy trees; relative abundance of branch galls (absent, light = difficult to see, moderate = easily seen but not abundant, and heavy = abundant); relative abundance of sweetfern rust (absent, light = less than 10 percent of stems infected, moderate = 30 - 50 percent of stems infected, and heavy = more than 50 percent of stems infected; and relative abundance of sweetfern ( same guidelines as used for gall rust). In addition, for each category (dead, expected to die, and healthy) one tree was randomly selected for measurement of DBH, Growth rate (size, in mm, of 1 in core), and number of 8-ft sticks per tree. The number of trees in each category was noted and the diameter, growth rate, and height data for the selected trees were used to represent all the trees in that category in each plot.

The number of trees in each category and the growth data were recorded on a Timber Sale ADP Tally Sheet, R9-2400-50 (Rev. 3/5/74) and the data was analyzed at Region 9 Headquarters, Milwaukee, Wisconsin. Volume losses were computed from the resulting computer print-outs.

LABORATORY

Branch galls were collected from ten dying trees in one of the severely affected plantations on the Chequamegon National Forest by district personnel and by the author from ten dying trees in a similarly affected area on the Nicolet National Forest, Lakewood Ranger District. The aeciospores from these galls were plated on 2% water agar, held at 18.5 c and examined after 24 hours for germ tube characteristics. The diagnostic criteria of Anderson and French, 1965, were used to determine if the fungus was that which caused Eastern or Western gall rust.

in the dark or light?

RESULTS

FIELD

The volume losses relative to the abundance of gall rust are summarized in Table 1. In plantations with moderate to heavy gall rust infection, an average of 5.7 percent of the volume was lost in 1978 and another 6.3 percent is expected to be lost prior to 1981. In plantations with light infection, an average of 2.5 percent of the volume was lost in 1977 and 3.1 percent is expected to be lost prior to 1981.

Volume losses and growth rates for 1978 and losses expected through 1981 are shown in Table 2. The sequence in which these plantations should be harvested, based on losses due to gall rust is also presented.

The plantations with high to moderate rates of infection with gall rust are expected to grow at a rate of 0.11 cords per acre per year whereas those with a low incidence of gall rust are expected to average a net growth rate of 0.41 cords per acre per year.

Sweetfern rust, Cronartium comptoniae Arth. was present in all the sale areas examined. In most plantations, it was found on less than 10 percent of the trees. On the Five Corner Tract, however, between 30 and 50 percent of the trees were infected.

## LABORATORY

The aeciospores from the galls collected on the Nicolet National Forest were typical of those of Cronartium quercuum. The average germ tube length for two trials was 452 mμ and 441 mμ In addition, the germ tubes were unbranched and often lysed at the tip. The aeciospores of the galls collected on the Chequamegon National Forest, however, resembled those of Endocronartium harknessii (J.P. Moore) Y. Hiratsura. In two trials, the mean germ tube lengths were 50 mμ and 64 mμ and the germ tubes were branched at the proximal end. ↑too short ?

## DISCUSSION

Mortality of jack pine on the Chequamegon and probably the Nicolet National Forests is considered to be related to gall rust. Healthy trees generally had less than three stem galls and fewer than 100 branch galls in the live crown (data collected independent of this evaluation by the author, and by Dave French, and Dale Smeltzer, University of Minnesota). Dying trees had from four to eleven stem galls and between 100 and 200 branch galls, and dead trees had the same number of stem galls but in excess of 200 branch galls.

The areas examined have a history of defoliation by the jack pine budworm and the soils are very sandy. The defoliation, the drought conditions in 1976 and 1977 and the stress caused by the galls probably had an additive effect which in total, caused the mortality of these trees.

The causal agent of the galls on the jack pine on the Chequamegon is not certain. Although the branching characters of the germ tubes of the aeciospores collected there resembled those of ~~the Peridermium~~ Endocronartium harknessii, the germ tube lengths were much shorter than previously reported (35 m to 125 m in this evaluation as opposed to 128 m to 220 m in previous studies). It is possible that since the galls were collected in late June that their viability was reduced.

If this fungus is ~~Peridermium~~ Endocronartium harknessii, it would be the first report of the fungus in Western Wisconsin. Previously, this fungus was reported on jack pine in Western Minnesota, Eastern Wisconsin, and the Upper Peninsula of Michigan and primarily on scotch pine in the Lower Peninsula of Michigan (Anderson 1965; Hart et. al. 1978).

Mortality, reduction in growth rate, and increased cull in jack pine due to sweetfern rust is well documented. Anderson and French (1964), reported little mortality and volume loss in trees younger than 40 years old; but a definite progression in mortality (28% - 52%) and in the percent of trees with visible decay (12% - 73%) in age classes of 41-50 through 71-80. Infected trees averaged one to two inches less in diameter at breast height. Gross et. al. (1978) reported an average decrease of 20 percent in tree size and an additional 11 percent due to cull. Table 3, constructed by the author from equations derived by Gross, may be useful in determining cull due to sweetfern rust. Much of the decay associated with sweetfern rust is due to the activity of the fungus, Fomes pini (Thore) Lloyd (Figure 1, 2).

## RECOMMENDATIONS

1. On sites in which gall rust previously caused extensive mortaility:
   a) Plant alternate species, if possible
   b) If jack pine is planted, use nursery stock of known seed source as opposed to a seed tree or shelterwood type of regeneration.

2. To reduce the incidence of sweetfern rust:
   a) Use alternate species on sites in which sweetfern is present
   b) Use herbicides or other types of site prep methods to remove the sweetfern from the prospective planting site.

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# LITERATURE CITED

Anderson, Gerald W. and David W. French.

1965. Differentiation of Cronartium quercuum and Cronartium coleosporioides on the basis of Aecispore germ tubes.

Anerson, Neil A. and D. W. French.

1964. Sweetfern rust on jack pine J. For. 62:467-471.

Anderson Robert L., and Imants Millers.

1975. Jack pine mortality, Washburn Ranger District, Chequamegon National Forest, Wisconsin. USDA For. Serv., Northeast. Area State and Priv. For. Eval. Rep. S-7-75, 4 pp.

Gross, Henry L., Robert F. Patton, and Alan R. Ek.

1978. Reduced growth, cull, and mortality of jack pine associated with sweetfern rust cankers. Can. J. For. Res. 8:47-53.

Hart, John H., Daniel G. Mosher, and Remi Ajewole.

1978. Occurrence of Endocronartium harknessii and Cronartium quercuum on scots and jack pine in Michigan's Lower Peninsula.

Table 1.--Percent volume loss in 10 jack pine timber sale areas (21 stands) on the Washburn Ranger District. Chequamegon National Forest showing relative abundance of gall rust.

| Sale name | Acres | VOLUME | | Relative abundance of gall rust[c/] |
|---|---|---|---|---|
| | | Percent dead[a/] | Percent dying[b/] | |
| Jack Crystal | 135 | 6.8 | 7.8 | M-H |
| Brinks North | 84 | 8.5 | 5.9 | M |
| Blueberry | 44 | 6.4 | 5.4 | M |
| Tri-Block | 121 | 0.9 | 5.9 | M |
| Sweetfern | 57 | 0 | 5.0 | L-M |
| Old Maid | 70 | 3.6 | 4.3 | L |
| 236 Road | 28 | 1.7 | 2.8 | L |
| Five Corner | 125 | 3.1 | 3.3 | L |
| V-T | 106 | 2.6 | 2.3 | L |
| U-Road | 41 | 1.3 | 1.1 | L |

[a/] Died in 1971

[b/] Expected to die prior to 1981

[c/] L = light - difficult to find, M = moderate - easy to see, but not abundant, H = heavy - abundant.

Table 2.--Current and expected volume losses in 10 jack pine timber sale areas on the Washburn Ranger District, Chequamegon National Forest, with priorities for harvest.

| Sale name | Sale number | Acres | Tree condition | Volume (cu. ft.) | Annual growth (cords/acre) | Annual loss (cords/acre) | Net gain or loss (cords/acre) | Priority for harvest |
|---|---|---|---|---|---|---|---|---|
| Jack Crystal | 1 | 135 | Living | 134,000 | | | | |
| | | | Dead[a/] | 10,700 | 0.44 | 0.50 | -0.05 | 1 |
| | | | Dying[b/] | 12,300 | | | | |
| Sweetfern | 8 | 57 | Living | 84,500 | | | | |
| | | | Dead | -0- | 0.45 | 0.40 | +0.05 | 2 |
| | | | Dying | 42,000 | | | | |
| Brinks North | 5 | 84 | Living | 107,500 | | | | |
| | | | Dead | 10,700 | 0.59 | 0.45 | +0.13 | 3 |
| | | | Dying | 7,500 | | | | |
| Tri-block | 10 | 121 | Living | 254,100 | | | | |
| | | | Dead | 2,300 | 0.85 | 0.70 | +0.15 | 4 |
| | | | Dying | 15,200 | | | | |
| Blueberry | 3 | 44 | Living | 54,300 | | | | |
| | | | Dead | 4,000 | Data not collected | | | 5 |
| | | | Dying | 3,400 | | | | |
| Old Maid | 2 | 70 | Living | 105,800 | | | | |
| | | | Dead | 4,100 | 0.69 | 0.35 | +0.30 | 6 |
| | | | Dying | 4,600 | | | | |
| Five Corner | 9 | 125 | Living | 204,000 | | | | |
| | | | Dead | 6,800 | 0.61 | 0.30 | +0.31 | 7 |
| | | | Dying | 7,300 | | | | |
| V-T | 7 | 106 | Living | 214,373 | | | | |
| | | | Dead | 5,800 | 0.73 | 0.25 | +0.47 | 8 |
| | | | Dying | 5,000 | | | | |

Table 2.--continued

| Sale name | Sale number | Acres | Tree condition | Volume (cu. ft.) | Annual growth (cords/acre) | Annual loss (cords/acre) | Net gain or loss (cords/acre) | Priority for harvest |
|---|---|---|---|---|---|---|---|---|
| 236 Road | 4 | 28 | Living | 87,800 | | | | |
| | | | Dead | 1,700 | 1.13 | 0.69 | +0.63 | 9 |
| | | | Dying | 2,700 | | | | |
| U-Road | 6 | 41 | Living | 75,800 | | | | |
| | | | Dead | 1,100 | 0.91 | 0.15 | +0.75 | 10 |
| | | | Dying | 923 | | | | |

[a]/Dead = died in 1978

[b]/Dying = expected to die prior to 1981

Table 3.--Percent volume loss in jack pine relative to tree height (no. of 8' sticks) and sweetfern rust canker height (ft)

| Volume loss (%)[a] | | | | | |
|---|---|---|---|---|---|
| | No. of 8' sticks | | | | |
| Canker length (ft) | 2 | 3 | 4 | 5 | 6 |
| 2 | **21** | **16** | **10** | 4 | 0 |
| 3 | **33** | **26** | **20** | 15 | 9 |
| 4 | **41** | **37** | **31**[b] | 26 | 20 |
| 5 | 55 | 47 | 42 | 36 | 30 |
| 6 | 65 | 58 | 52 | 46 | 41 |

[a] Constructed from equations derived by Gross et. al., 1978.

[b] Bold print indicates values for tree heights and canker lengths most frequently encountered for jack pine in the Lake States.

## FIGURE LEGENDS

Figure 1.--Jack pine stem showing fruiting bodies of the Red Ring Rot-Fungus, *Fomes pini*.

Figure 2.--Cross-section of jack pine stem showing the Red Ring Rot caused by the fungus, *Fomes pini*.